Nanoscale electronic inhomogeneity in oxides

Beamline: X1B

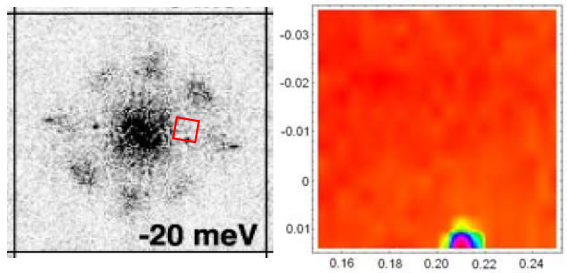
Technique:
Resonant soft x-ray scattering (RSXS); Molecular beam epitaxy (MBE)

Researchers:
P. Abbamonte, A. Rusydi, G. Blumberg, I. Bozovic, H. Eisaki, G. Gu, D. Buttrey

Publication:
"Crystallization of charge holes in the spin ladder of $Sr_{14}Cu_{24}O_{41}$", P. Abbamonte, G. Blumberg, A. Rusydi, A. Gozar, P. G. Evans, T. Siegrist, L. Venema, H. Eisaki, E. D. Isaacs, G. A. Sawatzky, to appear in Oct. 28 (2004) issue of *Nature*

Motivation: Transition metal oxides are characterized by narrow bandwidths, low carrier densities, and poor screening in the vicinity of the transition metal ion. The result is an electronic environment that on the border between atomic and band descriptions, in which the valence electrons undergo a competition between the desire to delocalize and to retain local valence bond order. This causes TMO's to electronically phase segregate on a nanometer length scale, giving them a diverse array of behavior uncluding colossal magnetoresistance, the formation of Wigner crystals and other types of charge and spin density waves, and, perhaps, high temperature superconductivity.

In this project we are using resonant soft x-ray scattering to investigate nanoscopic electronic ordering in oxides.



Comparison of RSXS to Fourier Transform STS. (left) STS measurements taken from ref. compared to (right) an off-resonance RSXS scan from X1B, taken from a BSCCO sample with the same stoichiometry. The RSXS scan region corresponds to the red inset. The well-known structural BSCCO supermodulation, for example, is reproducible between the two techniques.

Results: One recent success has been the discovery of a hole Wigner crystal in the spin ladder material $Sr_{14}Cu_{24}O_{41}$, which will appear soon in *Nature*. We have also studied the doping dependence of this phenomenon, providing important information about the relationship between commensurability and the formation of Wigner crystals in solids. We have also been studying the stripe phases which form in certain high T_c materials near 1/8 doping. In the near future we plan to investigate the relationship between the nanoscale inhomogeneity and the charge order and quasiparticle interference seen with scanning tunneling microscopy (STM) in $Bi_2Sr_2CaCu_2O_{8+\delta}$ at low temperature and the pseudogap regime, respectively (see figure above).